Quantity and Color Types of Pollen Collected by Honey Bees in a Hive in Panaewa, Hawaii

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ABSTRACT

The amount of pollen collected by the Western honey bee, *Apis mellifera* L. relative to pollen color types and rainfall was studied on the UHH Agriculture Farm Laboratory at Panaewa, Hawaii. During the one year experimental period, monthly pollen samples were obtained from the test hive and daily rainfall data were taken at the site. Pollen collected varied each month from a high of 200.7 g in March 1985 to a low of 34.4 g in October 1985. The amounts of pollen were related to the previous month's rainfall. There were a total of 7 color types of pollen, beige, yellow, white, orange, green, rust and purple. Of these color types, the beige, yellow, and orange were present throughout the year in higher quantities.

The Western honey bee, *Apis mellifera* L. (Hymenoptera: Apidae), a native of the Near East (Deodikar et al., 1959), is one of 6 bee families possessing the highest degree of social development in which the worker caste has evolved (Butler, 1982). Of the three castes, queen, drone and workers, the latter comprise the largest numbers and are responsible for most of the hive's functional activities. Workers care for the developing young, conduct general "house cleaning" duties, guard the hive and forage for food needs of the colony which include water, nectar, and pollen. Of these essential food needs, pollen is the most important one being the sole source of proteins, fatty substances, minerals and vitamins for the developing larvae and newly emerged adults. Thus, pollen is a vital requirement for larval development and colony survival (Haydak, 1934).

There is a mutualistic relationship between certain plants and the honey bee that assures the survival of both species. As stated above, pollen serves as a dietary requirement for the honey bee colony and is also the male gamete of flowering plants. Through evolution, plants relying on insect pollination, have developed specialized floral structures such as "landing platforms", "honey/pollen guides", distinctive patterns, complex passageways and traps which ensure both anther and stigma contact with the bee's body (Deodikar, 1959). Thus the honey bee is important for the pollination of plants including agricultural crops.

Today man, who has domesticated the honey bee, has acquired an appetite for pollen. Pollen, a fine powdery spore, rich in amino acids and B vitamins, is now an ingredient of many dietary tablets and energy food products. Newman (1984) estimates the U.S. pollen market at approx-

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imately 2.5 million dollars. Until other pollen substitutes are developed, pollen will be acquired from honey bees. In the process of collecting pollen, the honey bee satisfies its own needs and that of man as a food source and as crop pollinator.

This study was conducted to determine the 1) amounts of pollen, 2) pollen color types, and 3) effect of rainfall on the amount of pollen collected by honey bees in Hawaii since to date, there is no information on pollen types from Hawaiian floral sources available.

MATERIALS AND METHODS

Studies were conducted from November 1984 to October 1985 to determine the quantity of pollen and pollen types collected by bees in a hive on the University of Hawaii at Hilo Agricultural Farm Laboratory, Panaewa, Hawaii. Pollen was collected with the use of a Walter T. Kelly pollen trap (Fig. 1) consisting of 2 separation boards placed between the hive bodies securing the trap (Fig. 1A). The trap consisted of a simple entry port lined with a 5-mesh hardware cloth (Fig. 1B). As the foraging bees returned, they passed through the mesh which caused the pollen pellets in the corbicula to dislodge and fall into a pollen tray beneath the entry port. This tray served as the holding compartment for the dislodged pollen pellets (Fig. 1C).

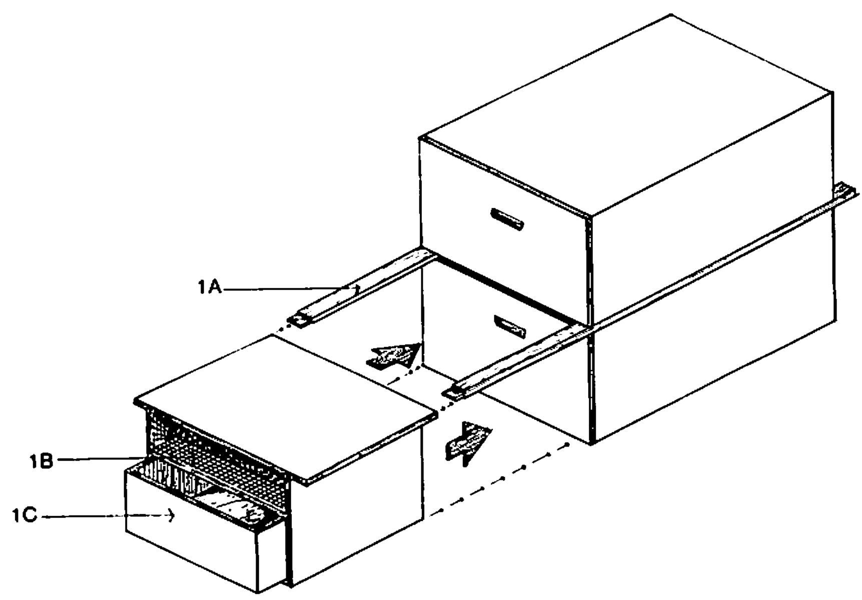

FIGURE 1. Trap used to collect pollen pellets. A — separation boards to hold pollen trap. B — screened entrance to remove pollen pellets from returning foragers. C — pollen tray to collect dislodged pollen pellets.

One hive located in the Panaewa Lab's apiary was selected for our study. The hive consisted of 2 standard hive bodies without a queen excluder. The entrance port for the pollen trap was located between the 2 hive bodies. The pollen trap was operated for a period of 10 consecutive days at the beginning of each month and the pellets collected constituted a monthly sample. The intermittent collection of 10 days a month was used so that the colony would not be completely deprived of pollen.

The quantity and types of pollen from each monthly sample were determined. Pollen samples collected each month were first weighed on a top loading balance. The pellets were then separated according to color (type) and then each type reweighed. A calibrated rain gauge was operated during the entire experimental period to obtain rainfall data.

RESULTS AND DISCUSSION

Quantity of Pollen

The pollen and rainfall data from this study are presented in Table I. The weight of the monthly pollen samples varied throughout the year with the largest amounts collected in March (200.7 g) and April (170.3 g). The smallest amount of pollen sample weighing 34.4 g was obtained in October. The fluctuations in monthly pollen collections appeared to be influenced by the total rainfall of the previous month. The largest pollen sample of March 1985 was preceded by greatest rainfall in February 1985. In the subsequent 4 months, the amount of pollen collected progressively decreased with a similar decreasing pattern of rainfall. There was a significant positive correlation between the monthly pollen sample weights during February 1985 to October 1985 and the total rainfall of the previous months (January 1985 to September 1985) ($r = 0.82$, $p = < 0.01$). Data previous to these months were not included in the analysis because data for December were not available.

Color Types

During this study 7 pollen color types were collected by bees: beige, orange, yellow, rust, green, purple and white. Noticeable variation in color occurred in the monthly samples (Table I). One significant example was the rust type which was collected only in January. The purple, white and green pollen types were recovered sporadically throughout the experimental period. These pollen type variations may be attributed to seasonal abundance in floral sources within the foraging area of the bees.

The amount and percent composition of the pollen types collected during this study are presented in Table I. The 3 major pollen types collected during the experimental period were the beige, orange and yellow. The beige pollen was collected in the greatest amount throughout the experimental period. The beige pollen ranged from a low of 60% in January to a high of 96.7% in August, greatly surpassing the other two major pollen types collected by nearly 5 fold in some months. The abundance of beige pollen collected may be due to the quantity and relative proximity of this floral source to the hive in comparison to other sources

TABLE I. Total weight and percentage of color types in monthly pollen samples taken from a hive in Panaewa, Hawaii.

Date	Color Types g (% composition)							Pollen	Rainfall
	Beige	Yel	Wht	Grn	Orng	Rust	Prple	(g)	(cm)
Nov 84	42.9	8.6	1.2	0.0	8.6	0.0	0.0	61.3	15.5
	(70.0)	(14.0)	(2.0)	(0.0)	(14.0)	(0.0)	(0.0)		
Jan 85	42.5	6.6	0.0	0.0	7.6	13.7	0.3	70.7	0.5
	(60.0)	(9.3)	(0.0)	(0.0)	(11.0)	(19.3)	(0.4)		
Feb 85	85.0	0.7	0.0	2.4	3.1	0.0	0.0	91.2	28.3
	(93.2)	(0.8)	(0.0)	(2.6)	(3.4)	(0.0)	(0.0)		
Mar 85	163.3	5.8	3.5	8.7	10.8	0.0	3.7	200.7	10.0
	(83.9)	(2.9)	(1.7)	(4.3)	(5.4)	(0.0)	(1.8)		
Apr 85	158.8	2.6	0.0	2.6	6.1	0.0	0.3	170.3	6.3
	(93.2)	(1.5)	(0.0)	(1.5)	(3.6)	(0.0)	(0.2)		
May 85	56.7	4.2	0.0	0.0	17.7	0.0	0.0	72.9	4.5
	(71.9)	(5.4)	(0.0)	(0.0)	(22.7)	(0.0)	(0.0)		
Jun 85	43.2	5.0	3.6	2.7	9.6	0.0	0.0	69.1	3.2
	(67.4)	(7.8)	(5.6)	(4.2)	(15.0)	(0.0)	(0.0)		
Jul 85	32.0	2.8	1.9	0.0	2.3	0.0	2.0	41.1	9.6
	(78.0)	(6.9)	(4.6)	(0.0)	(5.7)	(0.0)	(4.8)		
Aug 85	88.3	1.6	0.0	0.0	1.4	0.0	0.0	91.3	4.3
	(96.7)	(1.8)	(0.0)	(0.0)	(1.5)	(0.0)	(0.0)		
Sep 85	35.3	5.1	0.0	0.0	1.7	0.0	0.0	42.1	3.7
	(83.9)	(12.1)	(0.0)	(0.0)	(4.0)	(0.0)	(0.0)		
Oct 85	27.4	3.2	0.0	0.0	3.8	0.0	0.0	34.4	10.3
	(79.6)	(9.4)	(0.0)	(0.0)	(11.0)	(0.0)	(0.0)		

in the area. It may also be due to the attraction of the bees to flowers with this type of pollen.

Interestingly, there was an inverse relationship between the beige pollen type as compared to the yellow and orange pollen types. In nearly every month of the experimental period, with the exception of January, as the beige pollen type increased, the yellow and orange pollen collected decreased with the converse also noted. This relationship could possibly be due to the seasonal fluctuations of the flowering plants within the foraging range of the workers. The beige pollen may also have been gathered in high percentages (60-97% of the total monthly pollen sample) because its floral source is continually blooming. The other major floral sources (yellow and orange pollen types) may be blooming inconsistently and were gathered by workers only during high blooms because of their proximity to the hive. The beige type was collected less frequently during these major blooms of other pollen types because the beige floral sources may have been at a longer distance from the hive. When these other floral sources (yellow and orange) near the test hive ceased to bloom, the workers foraged on the constant beige pollen floral source.

In summary, the results of this study indicate that 1) the relative amounts and pollen types in the monthly samples varied throughout the year and 2) the monthly pollen samples were significantly correlated with the rainfall of the previous month. Further studies are now being conducted to identify the pollen types and to determine the relationship of the pollen sources relative to hive location.

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